§20. Up-Down Asymmetry of the Plasma in the Ergodic Layer of CHS

Nakamura, K., Iguchi, H., CHS Group

Plasma structures near and out side of the last closed flux surfaces (LCFS) have been measured by use of the lithium beam probe (LiBP) in CHS. There are two typical magnetic configurations for edge plasmas, namely, the inboard limiter configuration and the magnetic limiter configuration.

When the magnetic axis is shifted outward, a chaotic magnetic field layer appears surrounding the core plasma. The layer is formed because the magnetic field line wanders in and out and no closed flux surfaces are formed.

A lithium neutral beam with the energy up to 15 keV and with the equivalent beam current of a hundred microamperes is injected from the M-port (located upside of the torus). Light emission from the beam due to plasma particles impact excitation (670.8 nm) is collected through a window mounted on the O-port (located outside of the torus).

Experiments have been carried out for the magnetic axis of R_{ax} = 1.016 m and the magnetic field strength of 0.93 T on the axis. A hydrogen plasmas are produced by electron cyclotron resonance (ECR) heating with a gyrotron of 53 GHz. Neutral beam injection (NBI) heating with the beam energy of 40 keV is added. Plasma density is controlled by preprogrammed gas puff system. The average electron density is about 0.8×10^{19} m^{-3} in the ECH plasma and is 2×10^{19} m^{-3} in the NBI plasma. Two-dimensional profile of the electron density for the ECH plasma is shown in Fig.1, which shows that the electron density distribution of the ECH plasma shifts up-ward in the chaotic field region (x>1275 mm) near the separatrix. The NBI plasma also shows up-ward shift similar to the ECH plasma. Figure 2 shows the density distributions along vertical lines (a) ~ (e) in Fig.1. Up-down asymmetry is clearly shown. The density peak shifts further upward as horizontal location goes outward.

In order to see the effect of magnetic field direction on the plasma shifts, experiments for the reversed magnetic field direction have been carried out. The average electron densities are about 0.6×10^{19} m^{-3} and 0.8×10^{19} m^{-3} for ECH and NBI plasmas, respectively. Figure 3 shows the electron density profile in the ECH plasma along the same line (a) ~ (e) in Fig.1. The electron density distribution now shifts downward. It is found that the up-down asymmetry of electron density distribution reverses with the reversed magnetic field direction. Plasma shift is apparently in the direction of ion $\boldsymbol{B}\times\nabla B$ drift.

It is noted that the up-down asymmetry is sustained in steady state. The experimental result suggests that plasma equilibrium in the ergodic layer is not determined simply by the magnetic field structure. Since the $\boldsymbol{B}\times\nabla B$ drift is directed opposite for ions and electrons, electric field will be induced. Then the $\boldsymbol{E}\times\boldsymbol{B}$ drift will also affect the final flow patterns. Information on electric field is necessary to confirm this model, which is unknown at the moment. The observed asymmetry will be a source of loss flux asymmetry on divertor plates, which is observed various helical devices.

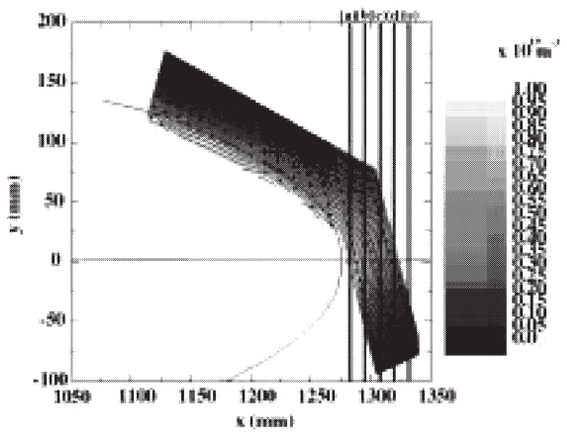

Fig. 1 Two-dimensional profiles of the electron density for the ECH plasma for magnetic limiter configuration.

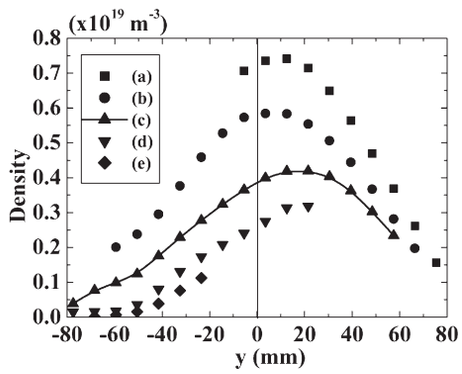

Fig. 2 Density distributions along vertical lines (a) ~ (e) in Fig 1.

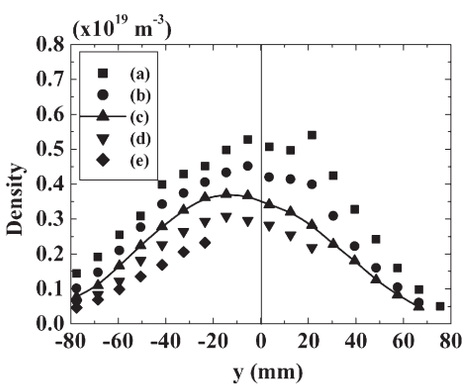

Fig. 3 Density distributions along vertical lines (a) ~ (e) in Fig 1 at the reversed magnetic field directions.